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Dedicated to V. F. Mironov on His 60th Anniversary

Formation of Copper Nanoparticles with Hyperbranched Polyesterpolyols as Template

O. I. Medvedeva[a], S. S. Kambulova[a], N. A. Ulakhovich[a], V. V. Vorobev[a], V. G. Evtyugin[a], E. V. Khaldeeva[b], and M. P. Kutyreva[a]*

[a] *Kazan Federal University, ul. Kremlevskaya 18, Kazan, Tatarstan, 420008 Russia*
**e-mail: mkutyreva@mail.ru*

[b] *Kazan Research Institute of Epidemiology and Microbiology, Kazan, Tatarstan, Russia*

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Abstract—New composite copper nanoparticles stabilized by hyperbranched polyesterpolyols of the second, third, and forth generations have been prepared via chemical reduction at different molar ratios of the precursors. The prepared stabilized copper nanoparticles have exhibited fungicide activity against *Penicillium funiculosum, Penicillium ochro chloron, Paecilomyces variotii, Aspergillus niger, Aspergillus oryzae*, and *Aspergillus terreus* strains. Copper nanoparticles stabilized by hyperbranched polyesterpolyols of the second and forth generations are hemocompatible.

Keywords: copper nanoparticles, hyperbranched polyesterpolyol, fungicide activity, hemolytic efficiency

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Nanoparticles of biophilic metals (silver, copper, and zinc) are highly promising for biomedical applications. Moreover, their studies have revealed that toxicity of biophilic metal nanoparticles is 7–50 times lower in comparison with the corresponding salts, nanoparticles exhibit high bioavailability, multifunctional and prolonged action, and promote metabolic processes when used in low concentration [1].

The objects of our studies are nanoparticles of copper and its compounds. Nanoparticles of copper and its oxides have been recognized for antimicrobial activity against many microorganisms including *Salmonella enterica*, *Campylobacter jejuni*, *Listeria monocytogenes* и *Staphylococcus aureus*, *Escherichia coli, Bacillus subtilis, Vibriocholerae, Pseudomonas aeruginosa, Streptococcus pneumoniae, Salmonella typhimurium*, and *Serratia marcescens* [2–5]. Physicochemical parameters and utilitarian properties (including biological activity) of the nanoparticle-based materials strongly depend on their morphology. The increase in the surface area to volume ratio of nanoparticles enhances their antibacterial activity [3–5], and the decrease in the nanoparticles size leads to the increase in their biological activity (and sometimes makes them more toxic) [3–7]. For example, CuO nanoflowers have exhibited higher antibacterial activity than nanorods, nanoleaves, and nanoflakes [5].

Altering the nature and structure of the stabilizing template is among convenient methods to govern the nanoparticles morphology; synthetic polymer stabilizers are opportune in this regard. Biosimilar nontoxic dendrimers or hyperbranched polymers with a core-shell structure are especially promising. Such molecules are advantageous over the linear polymers [8]: their three-dimensional structure contains voids, many heteroatoms, and functional groups. Polyamidoamine and polypropyleneimine dendrimers of different generations have been used as stabilizers of copper nanoparticles [9–13]. Such dendrimers contain inner tertiary amino groups and various functional groups at the exterior; they are capable of binding metal ions at the coordination sites, which can be further reduced to afford monodisperse metal nanoparticles encapsulated in the polymer. However, the use of polyamidoamines and dendrimers containing primary and secondary amino groups as the stabilizer can lead to high cytotoxicity of the nanoparticles [14]. Hence, the development of new polymeric stabilizers of biophilic